In Bacterial Diversity, Amazon Is A 'Desert'; Desert Is An 'Amazon'

January 10 2006

Ironically, in the diversity of soil bacteria, the otherwise species-rich Amazon is a more like a desert, while the arid desert is a teeming microbial Amazon, researchers have found. Their first-ever continental-scale genetic survey of soil bacteria revealed that the primary factor that seems to govern the diversity of soil bacteria is soil pH. Thus, the acidic soils of topical forests harbor fewer bacterial species than the neutral soils of deserts.

The researchers said that, since soil bacteria play a fundamental role in a vast array of ecological processes, their survey constitutes an initial step in a new research pathway to understanding that role.

Biologists Noah Fierer and Robert Jackson published their findings in the Early Online Edition of the *Proceedings of the National Academy of Sciences* the week of Jan. 9, 2006. Their work was sponsored by the National Science Foundation and the Mellon Foundation. Fierer, a former post-doctoral scientist at Duke University, is at the University of Colorado; and Jackson is in the Department of Biology and the Nicholas School of the Environment and Earth Sciences at Duke.

“Although soil bacteria have been studied for centuries, fundamental biological questions remain unanswered," said Fierer. “We probably know more about the organisms in the deepest ocean trenches than we know about the organisms living in soil in our backyards.

“We step on soil every day, but few people realize that 'dirt' supports a

complex community of microorganisms that plays a critical role on Earth, he said. "The number of bacterial species in a spoonful of soil is likely to exceed the total number of plant species in all of the United States."

According to Jackson, "Microbes are very important for most of the critical processes in nature. They are extremely important for the cycles that make nutrients available to plants and animals; and for much of the respiration that returns carbon back to the atmosphere as carbon dioxide. They also give off most of the important trace gases in our atmosphere like methane.

"Given this importance, it was really surprising to us that no one had tried to systematically explore the pattern of diversity of soil bacteria on a continent-wide scale. Part of the reason is such a survey is technologically challenging, and it's logistically challenging as well," he said.

In their survey, Fierer and Jackson collected 98 soil samples from across North and South America. They chose research sites in which considerable scientific data had already been collected that would enable them to assess the role of factors such as temperature and rainfall on diversity. These included many of the Long-Term Ecological Reserves in North America, supported by the National Science Foundation. While some of the samples were provided by scientists conducting studies in such research areas, other samples required remote treks through the Amazonian jungle, said Jackson.

The researchers assessed the microbial species diversity of their samples by performing "DNA fingerprinting" that would reveal the diversity of a particular kind of DNA called ribosomal DNA. This DNA is known to differ considerably among bacterial species, serving as a type of genetic "bar code" that can be used to differentiate species. While the measure

did not tell the researchers how many microbial species existed in the samples, it did give them a comparative measure of such diversity among the samples, said Jackson. The analyses revealed large differences among the samples in terms of diversity. The scientists then correlated that diversity with environmental factors, including latitude, temperature and soil pH.

"As biologists and ecologists, the factors that we think of typically as controlling plant and animal diversity didn't seem to correlate with the diversity of microbes," said Jackson. "Instead, the factor that correlated best with diversity was the pH of the soil they were growing in. It does make sense, since every biologist knows that when you culture microorganisms in the laboratory, the diversity and the health of those organisms tends to decrease in more extreme pHs." However, Jackson did not rule out the possibility of microbial "hot spots" that their broad survey might have missed.

Added Fierer, “These findings also suggest that soils with similar levels of acidity, even if those soils are thousands of miles apart, have similar bacterial communities.”

Jackson emphasized that "This is really just a first step to a better understanding of what controls microbial diversity around the world. Such understanding will offer important insights into the many processes soil microorganisms control -- including the carbon cycle of decomposition of organic matter and the nitrogen-fixing cycle -- both of which free nutrients for plants. Also, microbes control emissions of methane and other gases, many of which are important greenhouse gases," he said.

Source: Duke University